



# Returned Sample Science Inputs to Landing Site Selection

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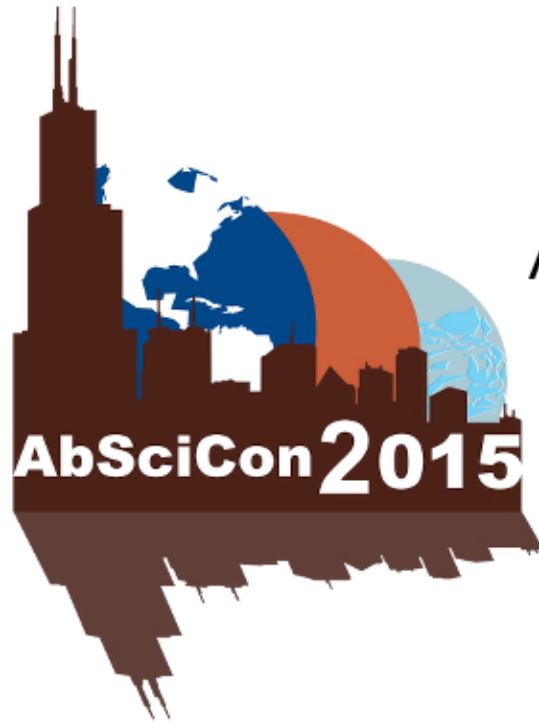


# Introduction

## Objective

- Determine landing site priorities as seen by the sample community, who have a major vested interest in the samples that may be returned by means of MSR.
- Systematic survey of two sectors in the community:
  - Astrobiology
  - Cosmochemistry/Petrology
- Most deeply held interests/desires flagged = ★

# Astrobiology inputs



Astrobiology Science  
Conference

**June 15-19, 2015**  
**Chicago, Illinois**

- *Largest gathering of astrobiologists of last 3 years*
- *Attendance ~750*
- *Landing Site Topic: Pre-meeting focus groups, Plenary panel discussion/presentation, Abstract/talk in technical session*



# Astrobiology Interests (1 of 5)

## Geologic Age

- ★ A geological period with wet/warm (habitable) environments.
- Not too early, not too late:
  - too early (life hasn't had a chance to start)
  - too late (want enough time to evolve, but not so much that life disappears)
- ★ A range of geologic ages important for evaluation of time-dependence.

# Astrobiology Interests

## (2 of 5)

### Environments

★ Require rocks that have interacted with a significant amount of water over a long period of time.

- Three main possibilities:
  - a. Sedimentary rocks deposited in long-lived standing water (lake, ocean),
  - b. Sustained near-surface hydrothermal conditions (e.g. sinter),
  - c. Deep, subsurface high-T hydrothermal

*Listed in  
draft priority  
order*

**Note:** Current weight of community opinion appears to favor a) over b). However, this has not been sufficiently vetted. Probably need a focused conference on this topic in 2016.



# Astrobiology Interests (3 of 5)

## **Diversity of low-T geochemical environments**

- Diversity increases odds of obtaining a sample with high biosignature preservation potential.
- Mineralogic diversity is a proxy for environmental diversity (e.g. composition, pH, temperature, water-to-rock ratio, duration, etc.).
- Useful for understanding the historical martian climate, and aqueous surface and near-surface processes.

# Astrobiology Interests (4 of 5)

## Sample Context

- ★ Sample context is critical to making defensible interpretations.
    - Need stratigraphy exposed in outcrop.
  - The issue of context is important enough that returning to a previous site where some context has already been established could be advantageous.
- Have not established community consensus position on this.*



# Astrobiology Interests (5 of 5)

## Organic Geochemistry

- ★ Samples that would preserve indigenous organic molecules.
- A key strategy is to access sites where rock is only recently exposed to radiation, e.g.:
  - Sites with active erosion
  - Recent shallow craters

# Cosmochemistry Inputs



- *Most important annual gathering of cosmochemists/meteoriticists—official conference of the Meteoritical Society*
- *Attendance ~400*
- *Landing Site Topic: Pre-meeting focus group, Brown bag lunch discussion/presentation, Abstract/poster in technical session*

## Diversity of Igneous Rocks

- ★ Sample diversity in all important measures is important.
  - Years of experience with paired meteorites shows that sample science advances only with rocks that are different from each other.
- ★ Multiple potential strategies available to achieve diversity (breccia, conglomerate, alluvial fans, etc.).

**Note:** Although sample context is important to both the A/B and cosmo/petrology communities, the required scale is different.

## Calibration of crater-counting chronology method

- ★ A datable unit with a defined crater retention age (Priority: Hesperian age).
  - No meteorite data from Hesperian: the critical point for refining the crater chronology curve.
- Best candidate: lava flow or an impact melt sheet.

## **Diversity of low-T geochemical environments**

- Minerals indicating conditions of alteration (pH, temperature, water-to-rock ratio, duration, etc.).
- Aid in the understanding of historical Martian climate, and aqueous surface and near-surface processes.
- Clay-bearing rocks specifically called out as of interest.
- Ground-truth for remote sensing provided by analysis of diverse mineral samples.

## Ejecta from Deep Craters

- Samples from the Martian interior (e.g. upper 1-2 km) may be available by this means.
- Potentially important dimension of understanding Mars as a system.
- Look for ejecta rays from nearby craters that cross the landing site.

*These samples may also be of some interest to astrobiology because of the potential for evidence of modern life.*

## **Metamorphosed terrane**

- Regional metamorphic processes would significantly complicate petrology, low-T geochemistry, and geochronology investigations.
- Recommend avoiding locations with concentrations of metamorphic minerals (prehnite, chlorite?).

*Also introduces unwanted complications for astrobiology.*














# **SYNTHESIS**

## **RETURNED SAMPLE SCIENCE CRITERIA FOR SITE SELECTION**

# DRAFT RSS Criteria

For Planning and Discussion Purposes Only

Shorthand	Criteria	AB	Cosmo
Age Range, Surface Water	Regional geology spanning a significant range of geologic age (wider range is better), and rocks must be present from the period of abundant surface water (TBC: LN, EH)		
Water-rock Interaction	Rocks that preserve evidence of extensive water rock interaction. Prioritization: 1. Sedimentary rocks deposited in long-lived standing water (lake, ocean); 2. Sustained near-surface hydrothermal conditions (e.g. sinter); 3. Deep, subsurface high-T hydrothermal		
Igneous Diversity	Potential to acquire diverse igneous samples (some diversification strategies: outcrop, float, alluvial fan, conglomerate, ejecta, breccia)		
Crater Calibration	Datable unit with a defined crater retention age (Priority: Hesperian age)		
Deep Ejecta	Ejecta from deep crustal impacts		
Low-T Geochem	Diversity of low-T (0-200°C) geochemical environments (esp. as indicted by diversity of mineralogic detections such as clays, sulfates, carbonates)		
Context	Local and/or regional context for samples can be established (some investigations require outcrop-level context, others only regional-level context).		
No Metamorphism	Absence of regional metamorphism	